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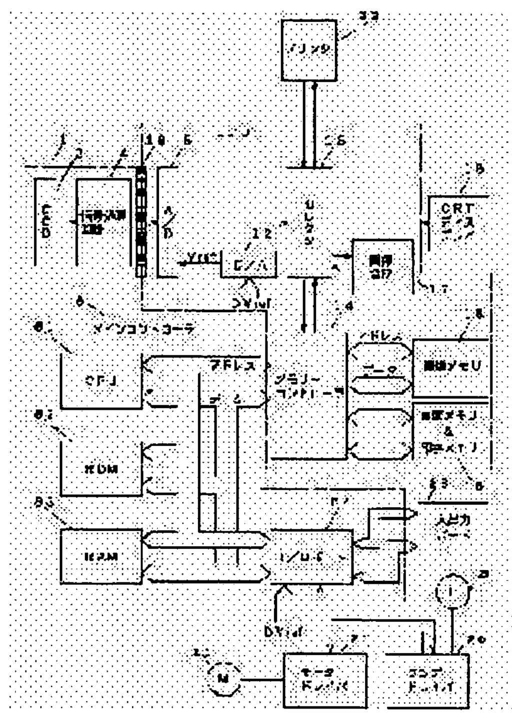
(54) INSPECTING DEVICE FOR IMAGE-PICKUP ELEMENT

(57)Abstract:



PROBLEM TO BE SOLVED: To accurately detect defective pixels of CCD.

SOLUTION: A light source 3, which selectively projects lights in two stage or more of intense light and weak light on the CCD 2, an achromatic color filter, an A/D converter 5, which converts the image-pickup signal at the time of the intense light into a first data at a comparison voltage Vref 1 at a high level and converts the signal to a second data at a low-level comparing voltage Vref 2 at the weak light, an image memory 15, which stores the first data and the second data, and an operating means 81, which computes a ratio Ri of the first data DM1 and the second data DM2, are provided. The maximum value Rimax and the minimum value Rimin of the ratio Ri of the all pixels are computed. Nonuniform value (PRNU)=Δ3/Rimax=(Rimax-Rimin)/Fimax is computed. When the value exceeds a threshold PRNUt, the CCD 2 is regarded as being defective.

LEGAL STATUS

[Date of request for examination]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to inspection of the photography sensibility of an image sensor including the array of many optoelectric transducers.
[0002]
[Description of the Prior Art] A CCD image sensor (it is only written as CCD below) is in one of the typical things of this kind of image sensor, and it is used for a digital copier, FAX, the image scanner, the camera, etc. For example, these days in the application of the read of a manuscript image, the inclination of the increment in the number of readout pixels and the increment in growing gigantic of a chip size and the total number of pixels by lines[two or more]-izing by colorization is followed. Here, the pixel of CCD means the smallest unit component of photo electric translation. Conversely, when it expresses, the line array or field array of many pixels is CCD.
[0003] The yield of CCD is falling by the increment in the number of pixels. One of the cause of the is for the probability of occurrence of the defective pixel on the way of manufacture to become high. Although there are what results from the construction material heterogeneity of the wafer itself, and a thing to generate in a processing process in a defective pixel, as a phenomenon of CCD, an output is not generated at all below in the quantity of light with a specific pixel.
[0004] There is heterogeneity of the output voltage that a generated voltage/quantity of light varies for every pixel in CCD, from the first, and this is expressed at the sensibility ununiformity index value PRNU and PRNU= [(peak price-minimum value in electrical potential difference which all pixels generate) /peak price] x100%. Above-mentioned dispersion is so large that the value of PRNU is large, CCD quality is low, and, as for CCD beyond a predetermined value, a PRNU value is disposed of as a substandard article.
[0005]
[Problem(s) to be Solved by the Invention] Although the above-mentioned PRNU value was using CCD beyond a predetermined value as the defective conventionally therefore, the yield did not go up but it had become the factor which raises the price of CCD.
[0006] Although processing called a shading compensation can amend above-mentioned dispersion, the defective pixel which cannot be amended is also generated in a shading compensation. Drawing 8 expresses the input-output behavioral characteristics of a normal pixel and a defective pixel, when the reflection factor of a manuscript is taken along an axis of abscissa and an output is taken along an axis of ordinate. When an ideal pixel shall show the photoelectric transfer characteristic shown in drawing 8 by **, although the pixel of the property shown as ** can be brought close to the photoelectric transfer characteristic shown by ** by the shading compensation in a reflection factor field higher than the manuscript reflection factor Xa (%), its dissociation from the photoelectric transfer characteristic shown by ** is so large that it is close to Xa (%), and it cannot obtain the quantity of light data corresponding to the quantity of light at all below by Xa (%). A defective degree is size (image repeatability is low), and the abnormality image of the shape of a vertical line of the direction of vertical scanning is

generated in the high concentration section of a rendering image, so that Xa (%) is large. Although there were some which are replaced by the last pixel as an approach it uses compensating CCD with a pixel defect, there was evil which a thin line grows fat in that case, or disappears conversely.
[0007] An above-mentioned PRNU value is what paid its attention to the deflection delta 1 shown in drawing 8 , and when this is large, it shows a large value. It makes an axis of ordinate as a CCD output by making an axis of abscissa into the direction of a list of the pixel of CCD, and drawing 6 sees the output of a pixel defect. If an output becomes small, it becomes impossible to disregard effect, although a pixel defect is not conspicuous at the time of 100% output with much quantity of light. That is, a pixel defect exists as offset over an output. However, even if deflection delta 1 is large in comparison, there is also a pixel which shows output voltage zero (Xa=0) with 0% of manuscript reflection factors, and shows the photoelectric transfer characteristic to which output voltage rises in proportion on parenchyma to buildup of a manuscript reflection factor. In this case, the amendment data in which the photoelectric transfer characteristic comparable as a normal pixel is shown by the shading compensation can be obtained. By [whose a manuscript reflection factor is a low value] by the way computing a PRNU value, it is thought that the precision of presumption of whether 0% of manuscript reflection factors shows output voltage zero (Xa=0) improves.
[0008] Then, how to inspect a defective pixel can be considered by making the quantity of light low and measuring the heterogeneity of output voltage. If the quantity of light is made low, as shown in drawing 6 , on the whole at 20% of quantity of lights, output voltage will decline. Then, by switching the comparison electrical potential difference of the A/D converter which changes the output voltage of CCD into digital data (image data) from the high value Vref1 to the low value Vref2, the quantization unit of digital conversion becomes small, as shown in drawing 7 , the scale of digital data can be expanded, and PRNU calculation precision becomes high.
[0009] however, even when detecting deflection delta 2 with the low quantity of light (for example, 20%) and computing a PRNU value based on it, there is not only the defective pixel that shows the offset of Xa which deflection delta 2 boils comparatively and is greatly shown in drawing 8 but a pixel which shows the photoelectric transfer characteristic to which 0% of manuscript reflection factors shows output voltage zero (Xa=0), and output voltage rises in proportion on parenchyma to buildup of a manuscript reflection factor from there. That is, the heterogeneity of the output voltage which can be amended by the shading compensation at the time of the low quantity of light exists. For this reason, precision cannot improve defective pixel detection only by making the quantity of light low and measuring the heterogeneity PRNU of output voltage, but even CCD which can be used is treated as a defect, and it becomes the cause of worsening the yield.
[0010] This invention aims at detecting the defective pixel of an image sensor with a sufficient precision in view of the above.
[0011]
[Means for Solving the Problem] An axis-of-abscissa value is set to x, setting the axis-of-ordinate value of Graf of drawing 8 as y, and if it is Xa=-b/a when the photoelectric-transfer-characteristic line shown in drawing 8 is approximated with y=ax+b, and the conditions which become Xa**0 are given, it will be b**0 and will become y**ax. If it assumes that it is the straight line by which it passes along a zero if its attention is now paid to photoelectric-transfer-characteristic line ** shown in drawing 8 , MB/MA will serve as a predetermined value (4) by a=MA/20=MB/80 MB/MA=80 / 20= 4. The gap from a predetermined value (4) of the actual value of MB/MA expresses the gap with the straight line which is photoelectric-transfer-characteristic line ** and which becomes y=ax.
[0012] Here, when based on photoelectric-transfer-characteristic line **, deflection delta3delta3=MB/MA-B/A of the B/A value of photoelectric-transfer-characteristic line ** to MB/MA expresses the gap to photoelectric-transfer-characteristic line [of photoelectric-transfer-characteristic line **] **. Phase comparison B/A is B/A=(MB-delta 2)/(MA-deltaA) from B=MB-delta 2 and A=MA-delta A.
It comes out, it is, and since (MA-deltaA of this value B/A) is a high-level field, the fluctuation to fluctuation of deltaA is small. That is, the possibility of rationalization by the shading compensation is

insensible to dispersion in the pixel output of a high high-level field. On the other hand, in the low field in which the offset Xa with difficult rationalization by the shading compensation may exist, since the fluctuation to fluctuation of delta 2 (MB-delta 2) is large, value B/A has large fluctuation of B/A. That is, the possibility of rationalization by the shading compensation is sharp to dispersion in the pixel output of a low low field. That is, B/A is the amount index value of gaps of view ultimate-lines ** to criteria ultimate-lines ** in which large weight is automatically inherent in the low field in which the offset Xa with difficult rationalization by the shading compensation may exist small weight to dispersion in the pixel output of the high-level field where the possibility of rationalization by the shading compensation is high.

[0013] So, in this invention, two or more steps of light, a light (80%) strong against an image sensor (2) and a taper (20%), is projected selectively. The photo-electric-translation signal of image pick-up equipment (1) while projecting each light is changed into the 1st digital data (A). When it precedes at least, the obtained digital data (A) under projection of a strong light (or taper) is memorized in memory and the 2nd digital data (B) is obtained during projection of a backward taper (or strong light) Or after memorizing the 2nd digital data (B) in memory, the relative value (B/A) of the thing of the same optoelectric transducer (i) of the 1st digital data (A) and the 2nd digital data (B) is computed.

[0014] In Order to Realize this, 1. Test Equipment of Image Sensor of Invention in this Application An image sensor (2) including the array of many optoelectric transducers, and the image pick-up equipment (1) which has the actuation circuit (4) which outputs the photo-electric-translation signal, Two or more steps of light, a light strong against an image sensor (2), and a taper The light equipment projected selectively An A/D-conversion means to change the photo-electric-translation signal of the; aforementioned image pick-up equipment (1) into digital data (5 12); The 1st data which is said digital data when having projected light with said light equipment (3, 10, 11) strong against an image sensor (2) (DM1i), (3, 10, 11) memory means (15); which memorizes at least one side of the 2nd data (DM2i) which is said digital data when said light equipment (3, 10, 11) has projected the taper on the image sensor (2) -- and It has operation means (81); which computes the relative value (Ri, B/A) of the thing of the same optoelectric transducer (pixel i) of said 1st data (DM1i) and 2nd data (DM2i). In addition, in order to make an understanding easy, in the parenthesis, the response element of the example which shows to a drawing and is mentioned later, or the sign of a response matter was written by reference.

[0015] Since the photoelectric transfer characteristic which is a pixel in case a relative value is optical projection of two or more level is expressed according to this, it is more possible than the case where the quality of each pixel of an image sensor (2) is judged only by optical projection of 1 level like before to make high precision of a quality judging of an image sensor (2).

[0016]

[Embodiment of the Invention]

2. Said strong light is the quantity of light which brings saturation to the photo-electric-translation signal of an image sensor (2), or the quantity of light (80%) near it, and although said taper is in the photo-electric-translation range (0 - 100%) of an image sensor (2), it is the quantity of light (20%) low enough.

[0017] 3. Said operation means (81) computes the ratio (Ri=DM2i/DM1i) of the thing of the same optoelectric transducer (i) of said 1st data (DM1i) and 2nd data (DM2i).

[0018] As opposed to dispersion in the pixel output of the high-level field where the possibility of rationalization according [a ratio (Ri, B/A)] to a shading compensation is high as mentioned above according to this small weight The large weight in the low field in which the offset Xa with difficult rationalization by the shading compensation may exist is automatically inherent. Since it is the amount index value of gaps of the photoelectric-transfer-characteristic line of each pixel of the image sensor (2) measured this time over criteria ultimate lines (**), the precision of a quality judging of an image sensor (2) based on this improves. Namely, a pixel defect can be discovered with a sufficient precision.

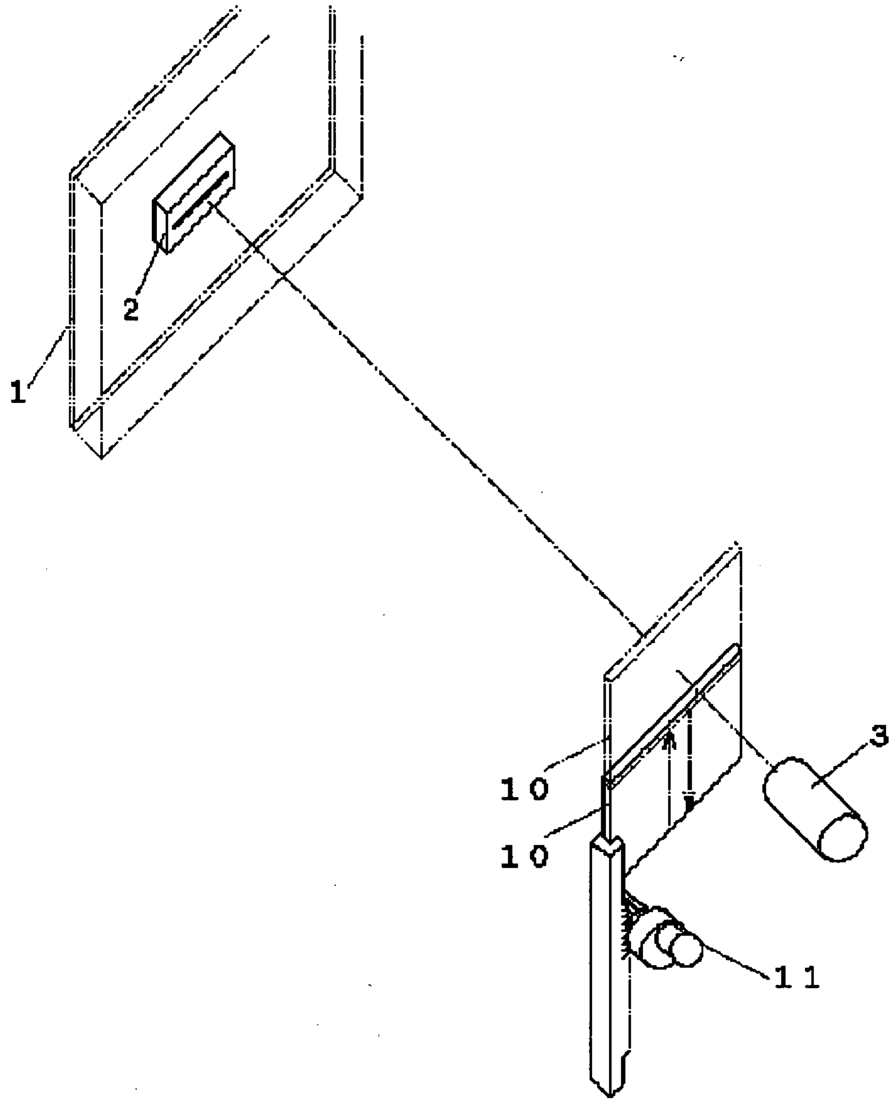
[0019] 4. When having projected the taper (20%) for the comparison electrical potential difference (Vref1) high when having projected light (80%) with said light equipment (3, 10, 11) strong against an image sensor (2), quantization unit-selection means (81); which gives a low comparison electrical

potential difference (Vref2) to said A/D-conversion means (5 12) is included further. According to this, the quantization unit of digital conversion when having projected the taper (20%) becomes small, as shown in drawing 7 , the scale of digital data can be expanded, digital conversion precision (resolution of data) when having projected the taper (20%) can become high, the precision of index value B/A can improve, and the quality judging precision of each pixel of an image sensor (2) can be raised.
[0020] 5. Said light equipment (3, 10, 11) includes ** and the device (11) from which it escapes from the light source (3) to the optical path between image sensors (2) for the filter (10) of an achromatic color, and this. The quantity of light can be reduced by putting in the filter of an achromatic color, without changing the spectral characteristic (from 80% to 20%).
[0021] Other objects and descriptions of this invention will become clearer than explanation of the example of the following which referred to the drawing.
[0022]
[Example] The outline of the optical system of one example of this invention is shown in drawing 1 . In drawing 1 , 1 is the image pick-up circuit board equipped with the digital disposal circuit 4 (drawing 2) which drives CCD2 and it and outputs a photo-electric-translation signal. 3 is the light source put on the distant enough place so that the quantity of light which hits CCD1 may become almost the same by the center section and the periphery. 10 is the filter of an achromatic color made into receipts-and-payments freedom between the image pick-up circuit board 1 and the light source 3. A filter 10 can drop the quantity of light, without changing the spectral characteristic of the light source 3. In this example, the luminescence reinforcement of the light source 3 is set as the brightness from which CCD2 produces the output of 80% of the abbreviation for the maximum (the brightest level is expressed) of rated output, and the achromatic color filter 10 is dimmed to the brightness which produces the output of 20% of abbreviation for the brightness which produces the output of 80% of abbreviation.
[0023] The achromatic color filter 10 is supported in the guide which is not illustrated so that it may move up and down between a top location (dimming location) and an evacuation location. The rack has fixed in the filter 10, revolution actuation of the pinion which gears on this rack is carried out by the electric motor 11 through a reducer, a filter 10 drives in a dimming location from an evacuation location by that normal rotation, and it is returned to an evacuation location from a dimming location by inversion.
[0024] The system configuration of the electrical circuit system of one example of this invention which has the optical system shown in drawing at drawing 1 is shown. The image pick-up circuit board 1 of the measuring object shown in drawing 1 is connected to image-processing equipment IPU through the connector 19, as shown in drawing 2 . The photo-electric-translation signal (video signal) which the digital disposal circuit 4 on the image pick-up circuit board 1 outputs is changed into digital data by A/D converter 5, and is written in an image memory 15.
[0025] The light from the light source 3 which separated enough is mostly irradiated by CCD2 as a parallel light. a digital disposal circuit 4 -- the signal from CCD -- magnification and sample hold -- direct-current playback is carried out and it inputs into A/D converter 5. Two kinds of 1st comparison electrical potential differences Vref1 and the 2nd comparison electrical potential difference Vref2 are alternatively given to A/D converter 5 by D/A converter 12. Although mentioned later, it is Vref1>Vref2. When the 1st comparison electrical potential difference Vref1 is given, A/D converter 5 classifies between 0 - Vref(s)1 into the field of a predetermined number (value which broke Vref1 per quantization of digital data), and generates the digital data showing to which field an input signal (video signal) belongs. When the number of field partitions is made the same, a quantization unit is large (quantization is), and a quantization unit is so small that Vref1 is large as the pair time (is quantization the top?). In addition, input signal level can be minutely expressed, so that at least a quantization furnace is small. Therefore, since it is Vref1>Vref2, the direction of digital data when having given Vref2 to A/D converter 5 expresses input signal level more minutely than digital data when having given Vref1.
[0026] When the condition which put the filter 10 on the evacuation location, i.e., the quantity of light, is large now, if a part of output of CCD2 is started, it will be assumed that it becomes like 100% of drawing 6 . The 2nd pixel is a pixel which only has the ununiformity of sensibility. Moreover, the 6th

pixel is a defective pixel. The 6th pixel does not become small, although heterogeneity will become small, for example in proportion to the quantity of light with 20% of quantity of light in the 2nd pixel if the quantity of light of such CCD is made low.
[0027] If the comparison electrical potential difference of A/D converter 5 is changed from Vref1 to the value Vref2 lower than it in order to make easy to measure sensibility heterogeneity in 20% of quantity of light, it is expandable like drawing 7 . delta 2 which computes the sensibility heterogeneity in this case becomes a value only with the big part of the 2nd pixel. The value of the sensibility heterogeneity which is originally in specification serves as substandard by this, and a result which lowers the yield is brought.
[0028] It becomes like drawing 5 and the 2nd pixel stops then, influencing sensitization heterogeneity in the value after division process by memorizing the data of one line in the quantity of light (the below-mentioned example 80% quantity of light) in memory 15 100%, and then carrying out division process of the 20% o'clock of data of low quantity of lights by the data at the time of previous 100% quantity of light. Thus, only CCD with a true defective pixel is detectable.
[0029] The outline of CCD inspection actuation of CPU81 of the Maine controller 8 shown in drawing 3 and drawing 4 at drawing 2 is shown. If a power source is switched on, after CPU81 initializes (step 1) and performs initialization of IPU and the Maine controller 8 interior here, it will perform initialization. This initialization is the same as that of initialization (steps 4-13) when the clear key of I / O board 23 is operated, and performs these similarly. In addition, in the following explanation, into a parenthesis, the word of a step is omitted and only a step No. figure is described.
[0030] A filter 10 is put on an evacuation location at the beginning of initialization (4). That is, if a filter 10 is in a dimming location, inversion actuation of the motor 11 will be carried out, and it will drive in an evacuation location. When it is in an evacuation location, actuation of a motor 11 is not performed. Next, 1 (sample No.1) is written in the register SNo which writes in the number (sample No.) of the image pick-up circuit board 1 (5). Next, a reference value Vrs2 is written for a reference value Vrs1 in the register Vref1 which stores the data showing the 1st comparison electrical potential difference Vref1 at writing (6) and a register Vref2 (7). And a reference value PLrs is written in the dimming ratio register PLr, and a reference value Dms is written in writing (8) and the threshold margin register Dm (9). and a ratio -- a threshold RAL -- computing -- a ratio -- (10) written in the threshold register RAL. And threshold PRNUt of the heterogeneity value PRNU is computed and it writes in the PRNU threshold register PRNUt (11). And the data which ****(ed) to the register at steps 5-11 are displayed on CRT display 18 (12). In addition, the indicative data of the alphabetic character with which the screen data displayed on CRT display 18 express read-out and data from an image memory 15, and a figure is read from the printing memory 16, and after it gives them to the image composition machine 17 and compounds them, it is given to CRT display 18. Next, burning of the light source 20 is directed to a lamp driver 20 (13).
[0031] If processing of the above-mentioned steps 1-13 and same processing are performed by initialization (1), if CPU81 has waiting and an operator input in the operator input from I / O board 23, it will process an input response. If an operator can change the dimming ratio of above-mentioned sample No. of Register SNo, Vref1 value of registers Vref1 and Vref2 and Vref2, and the dimming ratio register PLr, and the threshold margin of Register Dm and there is a modification input, CPU81 will carry out the updating writing of it at an applicable register, will perform steps 10 and 11, and will update RAL and PRNUt, and will also update the display of a CRT display.
[0032] If an operator operates the start key of I / O board 23, CPU81 outputs the data of a register Vref1 to D/A converter 12, and directs A/D conversion (15). Thereby, the 1st comparison electrical potential difference Vref1 is impressed to A/D converter 5. CPU81 writes the data (quantity of light data DM1i) showing the photo-electric-translation electrical potential difference which A/D converter 5 generates and which is each pixel of CCD2 here in a part for all the pixels (i=1-Ne) of CCD2, and one field (memory 1 is called) of an image memory 15 (16).
[0033] Next, CPU81 directs the filter actuation to a dimming location to Motor Driver 21, and, thereby, a filter 10 serves as a dimming location (17). Next, CPU81 outputs the data of a register Vref2 to D/A

converter 12, and directs A/D conversion (18). Thereby, the 2nd comparison electrical potential difference Vref2 is impressed to A/D converter 5. CPU81 writes quantity of light data DM2i which A/D converter 5 generates and which is each pixel of CCD2 here in a part for all the pixels of CCD2, and one field (memory 2 is called) of an image memory 15 (19).
[0034] And as 1 (pixel of No. 1), based on (20), each measurement data DM1i (data of memory 1) of pixel No.1-No.Ne of No. 1, and DM2i (data of memory 2), quantity of light ratio Ri=DM2 i/DM1i (= above-mentioned B/A) is computed, and the pixel assignment i is written in one field (memory 3) of an image memory 15 (21 22). Each quantity of light ratio Ri writes pixel No.i whose Ri was under the threshold RAL in one field (memory 4) of an image memory 15 as compared with a threshold RAL (data of Register RAL; refer to drawing 5) (23 24).
[0035] And CPU81 judges the functional quality as whole CCD2. Maximum Rimax and the minimum value Rimin of the quantity of light ratio Ri of CCD2 are extracted. For this reason, (25), the heterogeneity value PRNU [of all pixels (i=1-Ne)] 3/Rimax of PRNU=delta = Rimax-Rimin/Rimax -- computing -- or [that (28) and it exceed threshold PRNUt (defective)] -- checking -- (29) -- coming out so 1 which shows a defective is written in Register ERSNo (30), (31 which will clear Register ERSNo if it does not exceed). And sample No. of Register SNo is attached, and the data of memory 1-4 and Register ERSNo are outputted to a CRT display, and are printed out by the printer 22 (32). Next, a filter 10 is driven in an evacuation location and (33) and the sample No. data of Register SNo are incremented one time. It means that inspection of one CCD2 was completed above. If an operator removes the image pick-up circuit board 1 under current wearing from a connector 19, gives the print-out paper of a printer 22 to it and has non-inspected CCD, he will equip a connector 19 with it, and will operate the start key of I / O board 23. Answering this start input, CPU81 performs 15 or less-step processing again.

[Translation done.]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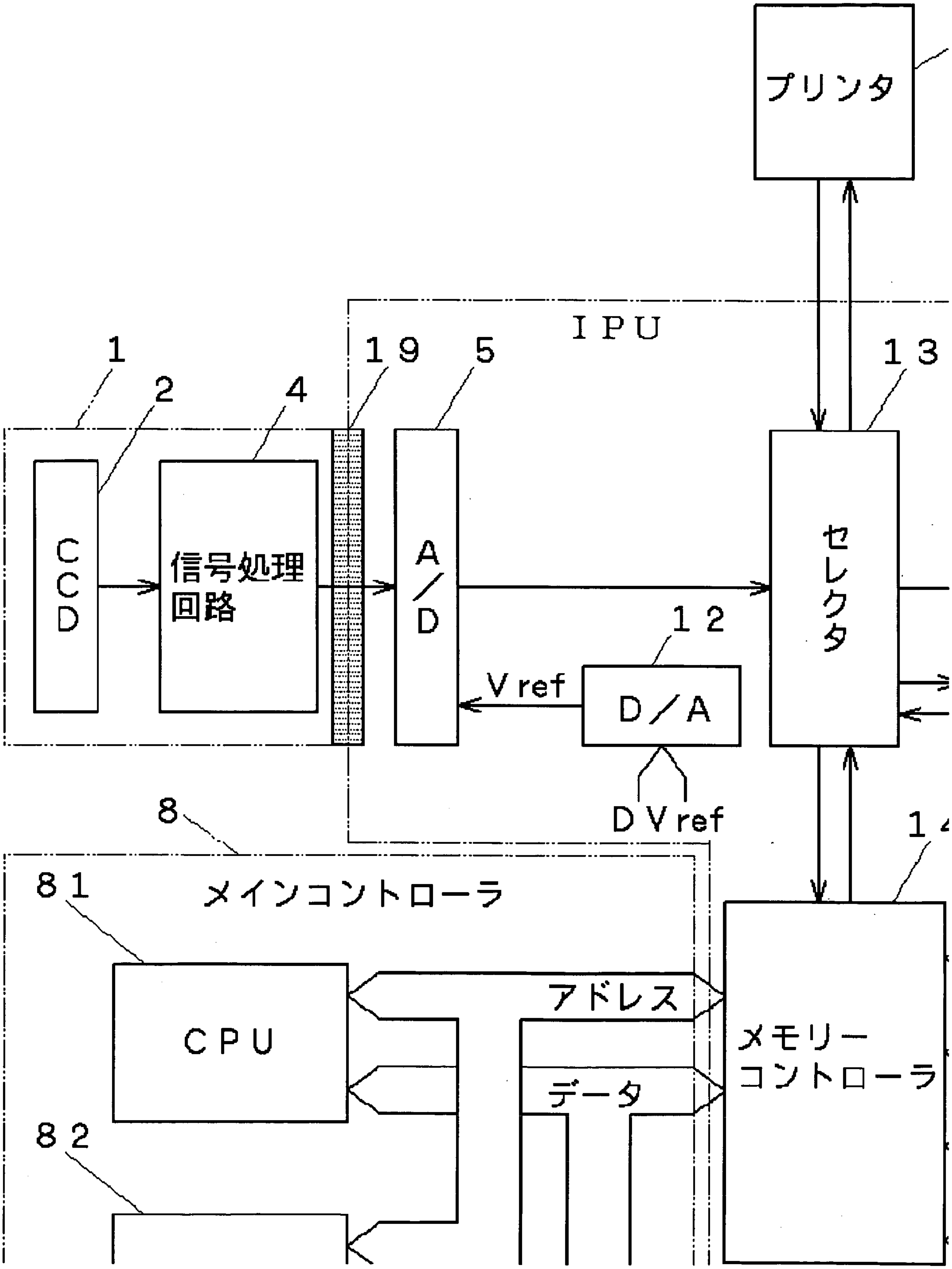
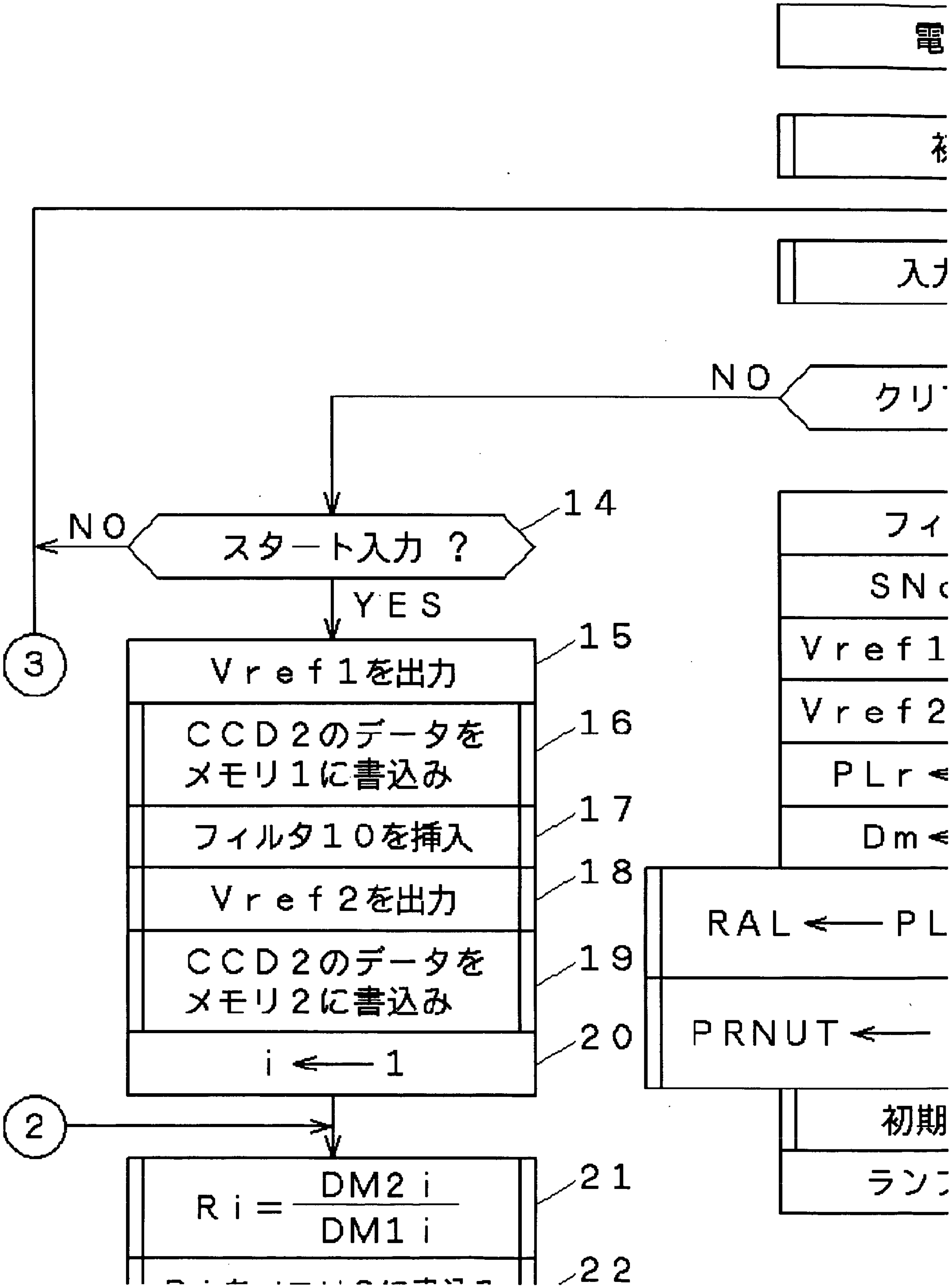


プリンタ
IPU
1
2
4
19
5
13
CCD
信号処理回路
A/D
セレクタ
12
Vref
D/A
DVref
8
メインコントローラ
81
CPU
82
アドレス
データ
メモリーコントローラ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16
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メモリ1に書込み
17
フィルタ10を挿入
18
Vref2を出力
19
CCD2のデータを
メモリ2に書込み
20
i ← 1
2
21
Ri = DM2i / DM1i
22
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Vref2
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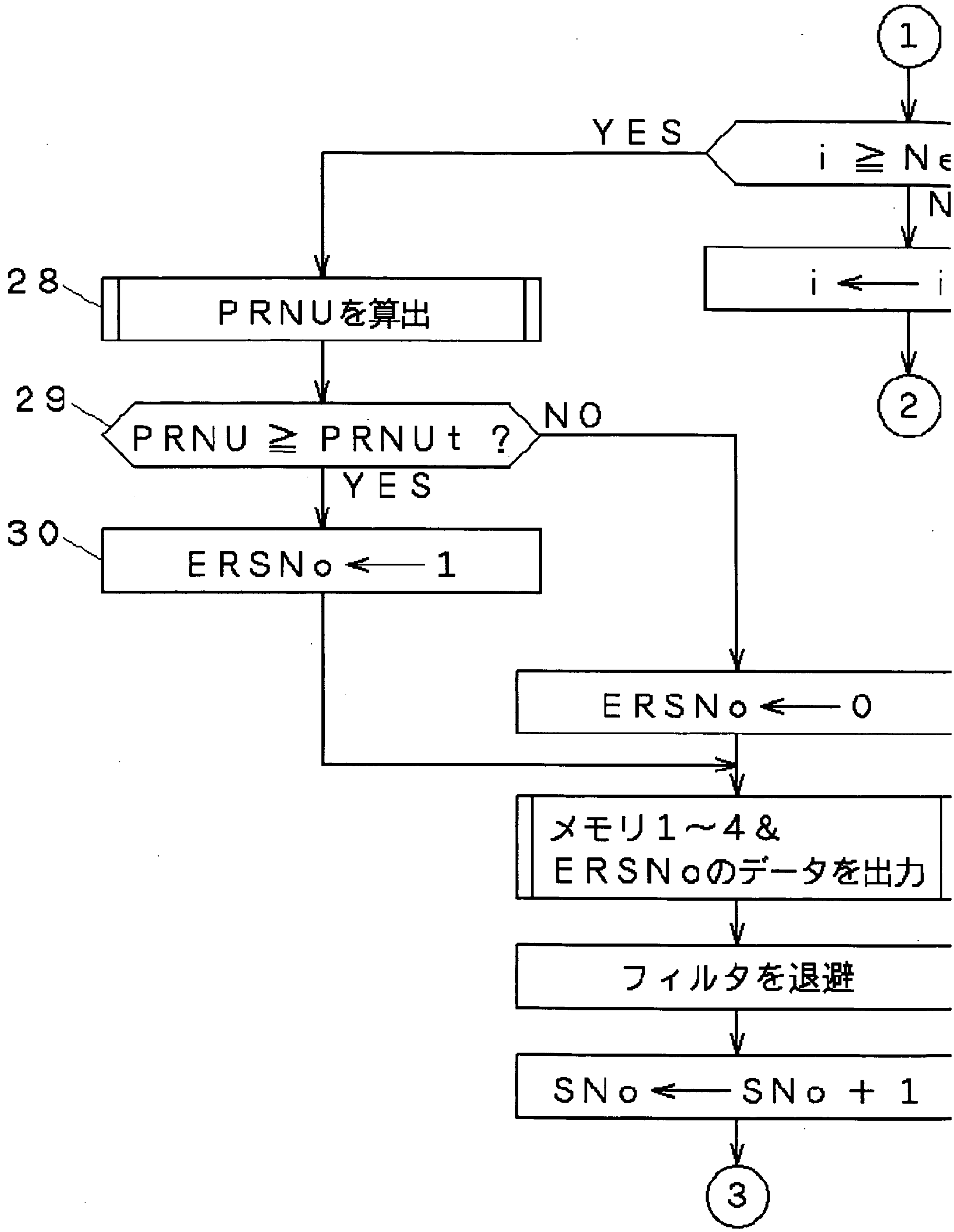
Dm ←
RAL ← PL
PRNUT ←
初期


1
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N
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2
28
PRNUを算出
29
PRNU ≧ PRNUt ?
NO
YES
30
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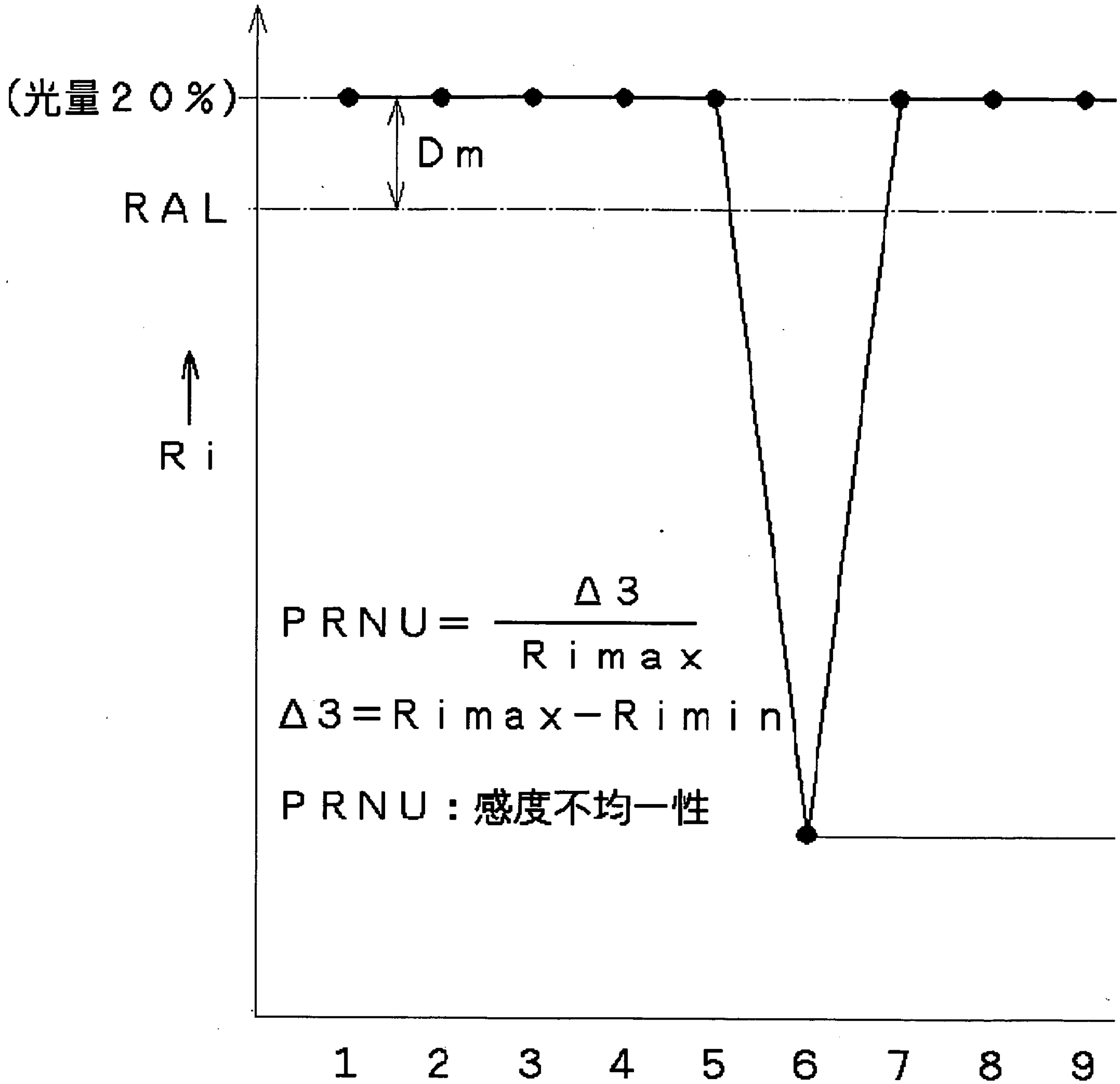
ERSNo ← 0
メモリ1～4&
ERSNoのデータを出力
フィルタを退避
SNo ← SNo + 1
3

Ｒｉ＝ＤＭ２ｉ／ＤＭ１


(光量２０％)
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ＰＲＮＵ：感度不均一性
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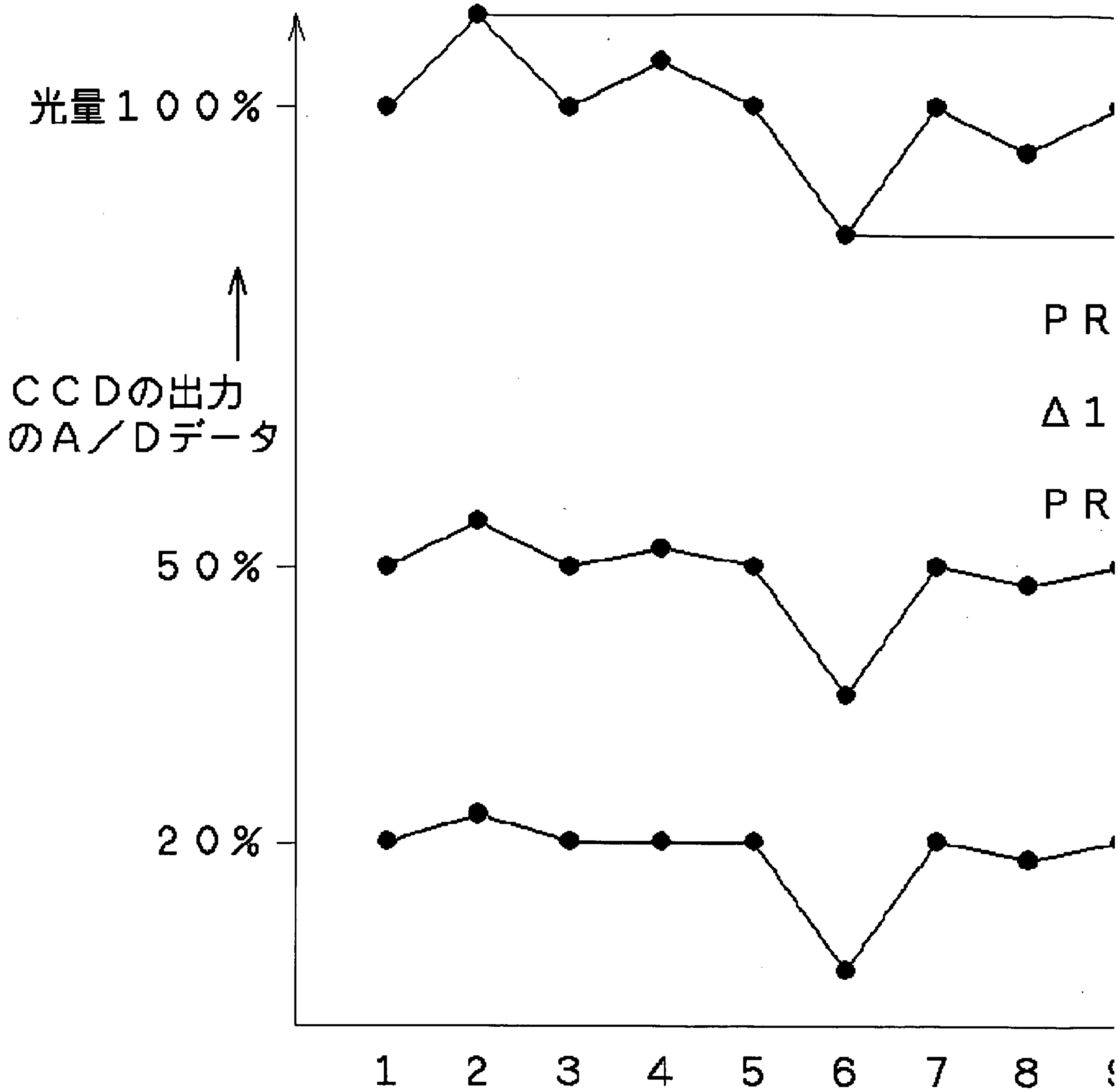
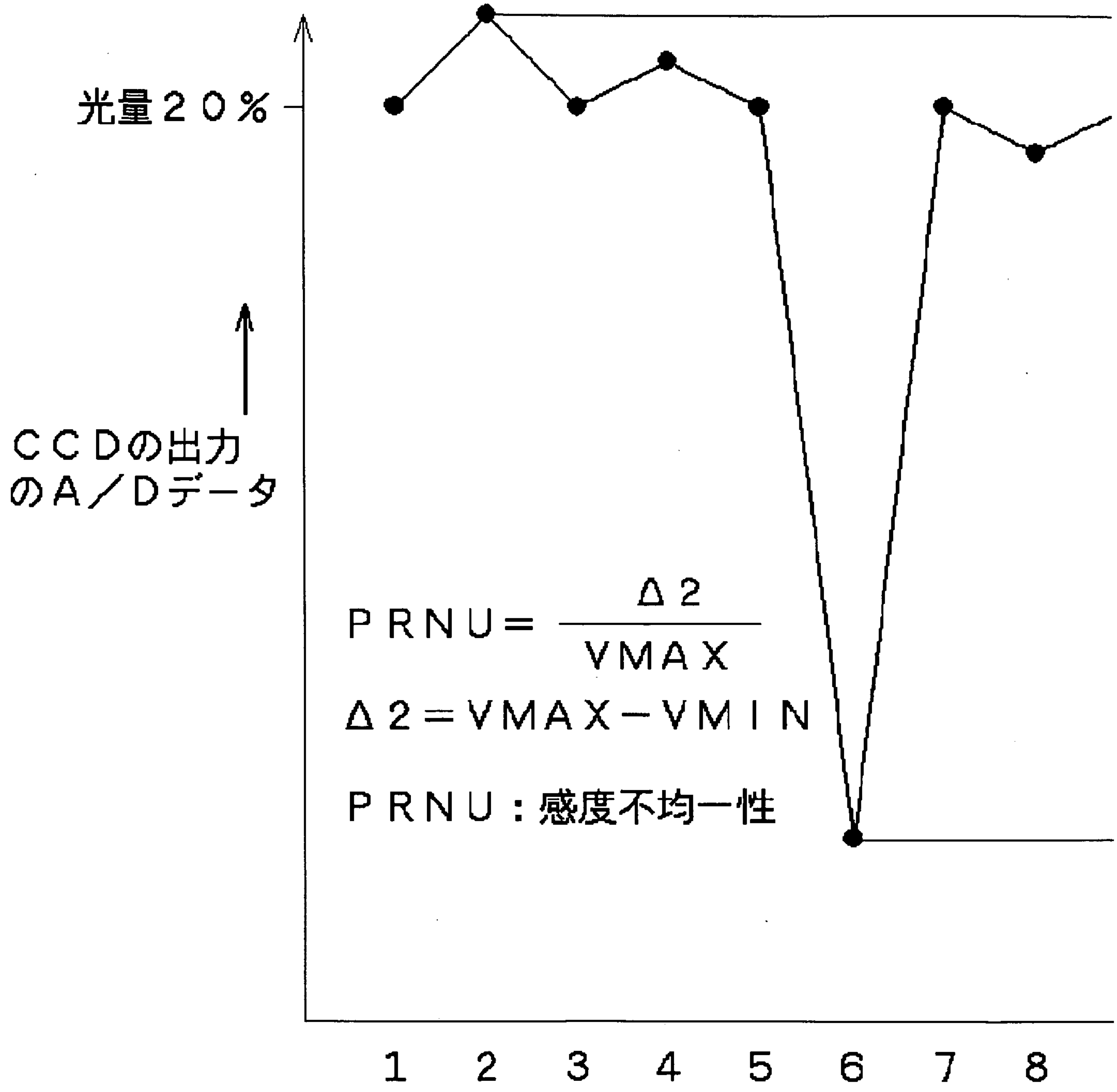
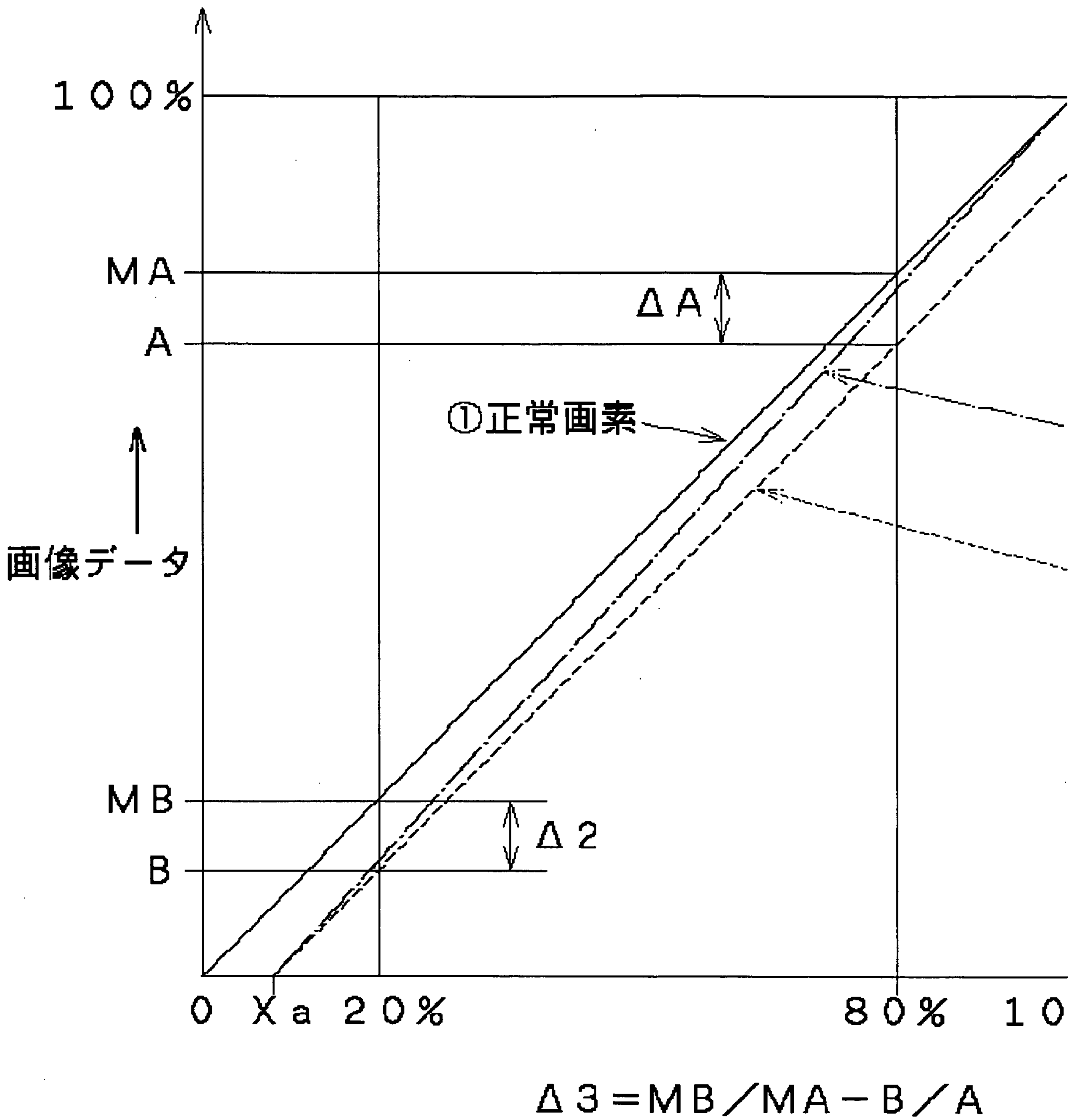
Ａ／Ｄの比較電圧Ｖｒｅｆ１



Ａ／Ｄの比較電圧Ｖｒｅｆ２

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MA
A
ΔA
①正常画素
画像データ
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B
Δ2
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Δ3=MB／MA−B／A